Opto-Thermal Effects of Gold Nanoparticle Concentrations on Photoacoustic and Ultrasonic Imaging of Blood Vessel Phantoms

Mohammad Khosroshahi, Andreas Mandelis [C, S] and Bahman Lashkari
Center for Advanced Diffusion-Wave Technologies (CADIFT), Department of Mechanical and Industrial Engineering, University of Toronto, Toronto, ON, Canada
mandelis@mie.utoronto.ca

Commercial imaging systems such as computed tomography and magnetic resonance imaging are frequently employed for observing living structures. However, they cannot visualize several tens of micron sized structures deep within the body. We describe a combined photoacoustic radar (PAR) and ultrasound (US) imaging system which was used to image blood vessel phantoms with high resolution based on the optical contrast and the anatomical details using gold enhanced contrast agents. The optimal optical power modulation power spectral density (PSD) was determined in the range of 0.5-0.8 MHz and 0.3-1.0 MHz for USI and PARI, respectively with the PAR amplitude of lower concentrations being higher than that of higher concentration samples. USI produced a better structural image of the tubing containing Au only and PARI produced a better functional image of the blood vessel. 2-D images of the blood vessel phantom were obtained. It is hypothesized that the change of the opto-thermal properties of higher gold concentration possibly decreases the osmolarity due to temperature increase and hence caused thermo-haemolysis of red blood cells (RBCs) which degraded the photoacoustic signal and thus the imaging contrast compared with the lower concentration.